Base 2003). The other five pools are on the Flying M Ranch conservation easement in eastern Merced County (Stone *et al.* 1988).

Three additional occurrences of *Neostapfia colusana* are on Federal land, which offers more options for conservation, but does not in itself constitute protection. Two are on a U.S. Department of Defense facility in Yolo County (Davis Communications Annex), which is in the process of being transferred to the ownership of Yolo County Parks (K. Fuller *in litt.* 2000). This site is the subject of a nonnative invasive plant management effort, particularly for *Lepidium latifolium* (pepperweed), and vernal pool restoration under a CalFed grant to benefit *N. colusana* and *Tuctoria mucronata*, another federally-listed plant included in this plan (N. McCarten *in litt*. 2004). The third occurrence on Federal land is on the Arena Plains Unit of the Merced National Wildlife Refuge in Merced County. Our National Wildlife Refuge system acquired the Arena Plains in 1992, and refuge personnel have been monitoring the *N. colusana* population annually since 1993. Although the refuge allowed grazing to continue on the Arena Plains after it was purchased, temporary electric fencing was placed around the *N. colusana* pool to exclude cattle in one year when the plant population was deemed to be particularly vulnerable (D. Woolington pers. comm. 1997, J. Silveira *in litt.* 2000).

9. *ORCUTTIA INAEQUALIS* (SAN JOAQUIN VALLEY ORCUTT GRASS)

a. Description and Taxonomy

Taxonomy.—Hoover (1936*b*) first published the scientific name *Orcuttia inaequalis* for San Joaquin Valley Orcutt grass. A 1935 collection from "Montpellier [sic], Stanislaus County" was cited as the type specimen (Hoover 1936*b*). Hoover (1941) subsequently reduced this taxon to a variety of California Orcutt grass (*Orcuttia californica*), using the combination *Orcuttia californica* var. *inaequalis*. Based on differences in morphology, seed size, and chromosome number, Reeder (1980) restored the taxon to species status, and the scientific name *Orcuttia inaequalis* is thus currently in use (Reeder 1993). *Orcuttia inaequalis* is a member of the grass family (Poaceae), subfamily Chloridoideae, and is in the tribe Orcuttieae (Reeder 1965). The genus *Orcuttia* is the most evolutionarily advanced group within the tribe (Keeley 1998, L. Boykin *in litt.* 2000). Alternative common names for this species are San Joaquin Valley orcuttia (Smith *et al.* 1980) and San Joaquin Orcutt grass (U.S. Fish and Wildlife Service 1985*c*).

Description and Identification.—Characteristics common to all members of the Orcuttieae were described earlier in this document in the *Neostapfia*

colusana species account. Species in the genus *Orcuttia* are characterized by an inflorescence consisting of narrow, flattened, distichous spikelets, each of which has two glumes at the base. *Orcuttia* species produce three different types of leaves during their life cycle: a submerged basal rosette of five to eight cylindrical, juvenile leaves; intermediate leaves in which the submerged portion is cylindrical but the upper portion has a flat, floating blade; and terrestrial leaves with a flattened blade and loosely sheathing base, which develop after the pools dry (Keeley 1998).

Mature plants of *Orcuttia inaequalis* grow in tufts of several erect stems, each of which ranges from 5 to 30 centimeters (2.0 to 11.8 inches) in length. The entire plant is grayish-green, due to the long hairs on the stem and leaves, and the plant produces exudate. Terrestrial leaves are 2 to 4 millimeters (0.08 to 0.16 inch) wide. The oval lemmas are 4 to 5 millimeters (0.16 to 0.20 inch) long and their tips are divided into five teeth approximately 2 millimeters (0.08 inch) long; the central tooth is longer than the others, hence the name *inaequalis* ("unequal"). Each spikelet is flattened and contains 4 to 30 florets. Both rows of spikelets grow towards one side. The spikelets are crowded near the top one-third of the stem, producing a head-like inflorescence 2 to 3.5 centimeters (0.8 to 1.4 inches) long. Each caryopsis is 1.3 to 1.5 millimeters (0.05 to 0.06 inch) long (Hoover 1941; Crampton 1976; Reeder 1982, 1993). The seeds averaged 0.28 milligram (1×10^{-5} ounce) in one population, although seed weight likely varies among sites (Griggs 1980). *Orcuttia inaequalis* has a diploid chromosome number of 24 (Reeder 1980, 1982).

The pith-filled stems, lack of both leaf sheaths and ligules, and presence of exudate distinguish *Orcuttia inaequalis* (and all members of the Orcuttieae) from grasses in other tribes. The elongate, distichous spikelets with oval lemmas and glumes differentiate *Orcuttia* species from *Neostapfia*, which has a cylindrical head with the spikelets arranged in a spiral, fan-shaped spikelets and lemmas, and no glumes. The unequal lemma teeth in *O. inaequalis* distinguish it from *O. pilosa* and *O. tenuis*. *Orcuttia californica* is similar to *O. inaequalis* but the former does not have a head-like inflorescence, has few hairs on the plant, and grows only near the California-Mexico border. *Orcuttia inaequalis* has shorter lemmas, shorter bristles, and smaller seeds than *O. viscida*. Furthermore, each species of *Orcuttia* has a unique chromosome number (Reeder 1982).

b. Historical and Current Distribution

Historical Distribution.—*Orcuttia inaequalis* has always been restricted to the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998) (**Figure II-13**). The earliest collection was made in 1927 from the

Fresno-Madera County border near Lanes Bridge (California Natural Diversity Data Base 2003). Hoover (1941) mentioned collections from eight sites in Fresno, Madera, Merced, Stanislaus, and Tulare Counties. A total of 20 occurrences had been reported by the mid-1970s, all in the same 5 counties (Crampton 1959, California Natural Diversity Data Base 2003), but none remained as of the late 1970s (Griggs 1980, Griggs and Jain 1983). However, 20 new occurrences were discovered within the following decade, including 16 in Merced County, 3 in Madera County, and 1 in Fresno County (Stone *et al.* 1988, California Natural Diversity Data Base 2003).

Current Distribution.—Since 1990, 18 additional occurrences of *Orcuttia inaequalis* have been found, including 1 in Tulare County (EIP Associates 1999, C. Witham *in litt.* 2000*b*, California Natural Diversity Data Base 2005) and 5 on ranches in Merced County (California Natural Diversity Data Base 2005), with another 1 that was established artificially (Stebbins *et al.* 1995). Of the 52 occurrences of *O. inaequalis* catalogued, 32 are presumed to be extant; 17 are extirpated and 3 others are considered possibly extirpated because the habitat has been modified (California Natural Diversity Data Base 2005). However, only 3 of the occurrences presumed extant have been revisited within the past decade, so even the most recent information is outdated. This species has apparently been extirpated from Stanislaus County but remains in Fresno, Madera, Merced, and Tulare Counties (Stone *et al.* 1988, Skinner and Pavlik 1994, California Natural Diversity Data Base 2003). *Orcuttia inaequalis* does not occur outside of the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998). The primary area of concentration of presumed extant occurrences is northeast of Merced in Merced County, with 19 occurrences (59 percent) on the Flying M Ranch and adjacent lands (EIP Associates 1999, C. Witham *in litt.* 2000*b*, California Natural Diversity Data Base 2005). Eastern Merced County is considered a critical region for the conservation of this species from the perspective of being located near the historical geographic center of the range, for harboring a large majority of the extant occurrences, and for harboring one of the largest incompletely surveyed blocks of quality habitat within the species' range (Vollmar 2002).

The Lanes Bridge area of Madera and Fresno Counties has the second highest concentration, with seven occurrences (22 percent), including the introduced population. The remaining six occurrences include three in the Le Grand area of Merced County, two on the tabletops near the San Joaquin River in Madera and Fresno Counties, and one in northwestern Tulare County (Stone *et al.* 1988, Stebbins *et al.* 1995, California Natural Diversity Data Base 2003).

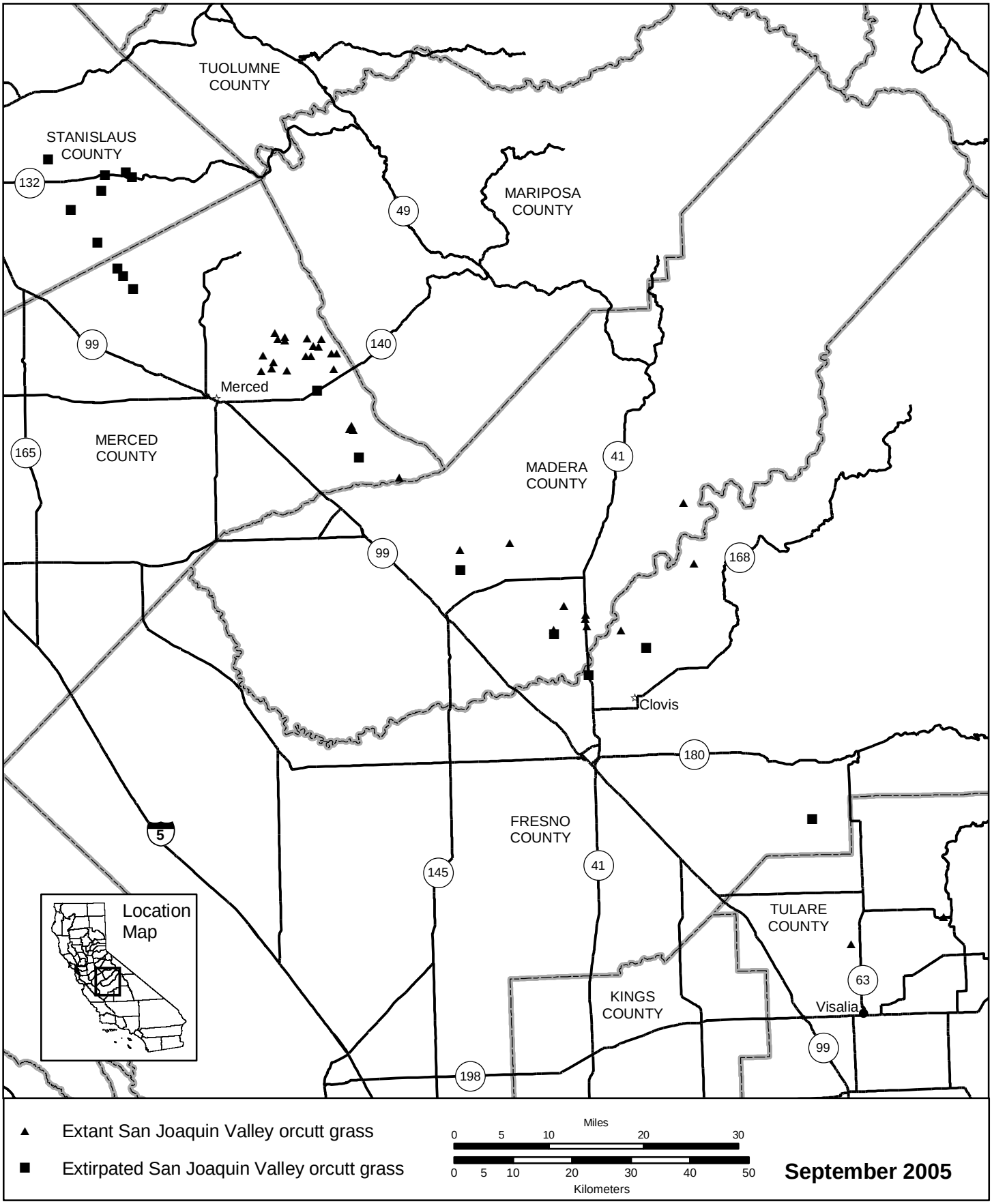

Figure II-13. Distribution of *Orcuttia inaequalis* (San Joaquin Valley Orcutt grass).

c. Life History and Habitat

Many life-history characteristics for *Orcuttia inaequalis* are common to the entire tribe and have been discussed earlier in this document. Certain other aspects of the life history are shared by *Orcuttia* and *Tuctoria* species, but not by *Neostapfia*. One of these aspects is the pattern of flowering. The first two flowers on a given plant open simultaneously and do not produce pollen until the ovaries are no longer receptive. Thus, if they are fertilized it must be with pollen from another plant. Flowers that open subsequently may receive pollen from the same plant or others (Griggs 1980). *Orcuttia* and *Tuctoria* species are believed to be outcrossers based on estimates of genetic diversity (Griggs 1980, Griggs and Jain 1983). Seed production in *Orcuttia* and *Tuctoria* species can vary two- to three-fold among years (Griggs 1980, Griggs and Jain 1983).

Another suite of life history characteristics is shared among all Orcutt grasses (*Orcuttia* species), but not other genera in the Orcuttieae. In particular, seeds of *Orcuttia* species germinate underwater in January and February (Griggs 1980, Griggs and Jain 1983, Keeley 1998), after being colonized by aquatic fungi (Griggs 1980, 1981). This observation was supported by Keeley's (1988) research, which indicated that fungicide inhibited germination of *O. californica* seeds, but did not affect *Tuctoria greenei* seeds. Detailed germination studies have not been conducted on all species, but cold treatment and other forms of stratification promoted germination in *O. californica* (Keeley 1988), *O. pilosa*, and *O. tenuis* (Griggs 1974, as cited in Stone *et al.* 1988) and most likely benefit other *Orcuttia* species as well. In an experimental study of *O. californica*, seeds germinated equally well in the light or the dark and could germinate whether exposed to air or anaerobic conditions; maximum germination was achieved in anaerobic conditions following cold stratification (Keeley 1988).

Orcuttia plants grow underwater for 3 months or more and have evolved specific adaptations for aquatic growth (Keeley 1998). Among these adaptations is the formation of the three different leaf types. The well-developed rosette of juvenile leaves is more specialized than those in *Neostapfia* or *Tuctoria* species, however (Keeley 1998). The floating-leaf stage is unique to *Orcuttia* species; these leaves form as water in the pool warms and remain as long as the standing water lasts (Hoover 1941; Griggs 1980, 1981; Reeder 1982; Keeley 1998). Aquatic leaves of *Orcuttia* species also lack stomates, even though they are present on the juvenile leaves of both *Neostapfia* and *Tuctoria* (Keeley 1998).

As soon as the pools dry, normally in June or July, Orcutt grasses begin producing their typical terrestrial leaves (Hoover 1941; Griggs 1980, 1981; Reeder 1982; Keeley 1998). Inflorescences appear within a few days after the water evaporates. June and July are the peak months of flower production for

most species, although flowering may continue into August and September in years of above-normal precipitation (Griggs 1980, 1981). Late-spring rains may prolong the flowering season (Griggs 1981, Griggs and Jain 1983), but inundation is more likely to kill flowering individuals (J. Silveira *in litt.* 1997). Spikelets break apart and scatter their seeds when autumn rains arrive (Reeder 1965; Crampton 1976; Griggs 1980, 1981).

Reproduction and Demography.—Griggs (1980) conducted demographic and genetic studies of one Fresno County population of *Orcuttia inaequalis* during spring 1976. In that year, each plant in the population produced an average of approximately 8 stems, 1,783 florets, and 254 seeds. The floret-to-seed ratio indicated a relatively good rate of pollination. Survival rates were not determined. Annual population estimates indicated that 1976 and 1978 were favorable years for the Fresno County population. Genetic diversity was high, even among plants grown from seeds collected from the same plant; among-population diversity was not evaluated for this species. The enzyme systems of *O. inaequalis* were most similar to those of *O. tenuis* (Griggs 1980, Griggs and Jain 1983).

Habitat and Community Associations.—Typical habitat requirements for all members of the Orcuttieae were described above under *Neostapfia colusana*. *Orcuttia inaequalis* occurs on alluvial fans, high and low stream terraces (Stone *et al.* 1988), and tabletop lava flows (Stebbins *et al.* 1995, California Natural Diversity Data Base 2003). This species grows in Northern Claypan, Northern Hardpan, and Northern Basalt Flow vernal pools (Sawyer and Keeler-Wolf 1995) within rolling grassland (Crampton 1959). Occupied pools range in surface area from 0.014 to 4.9 hectares (0.05 to 12.1 acres), with a median area of 0.62 hectare (1.54 acres) (Stone *et al.* 1988). *Orcuttia inaequalis* has been reported from elevations of 30 to 755 meters (100 to 2,475 feet); the highest-elevation sites are those on the tabletops of Fresno and Madera Counties (Stebbins *et al.* 1995, California Natural Diversity Data Base 2003).

Soils underlying *Orcuttia inaequalis* pools are acidic and vary in texture from clay to sandy loam. Soil series represented include the Hideaway series on Fresno-Madera County tabletops, and Amador, Cometa, Corning, Greenfield, Los Robles, Madera, Peters, Pollasky-Montpellier complex, Raynor, Redding, and San Joaquin soil series elsewhere in the range. Underlying layers at historical or extant occurrences included iron-silica cemented hardpan, tuffaceous alluvium, and basaltic rock from ancient volcanic flows (Stone *et al.* 1988, Stebbins *et al.* 1995, EIP Associates 1999, California Natural Diversity Data Base 2003).

The plants most commonly associated with *Orcuttia inaequalis* are *Eryngium* spp., *Plagiobothrys stipitatus*, *Neostapfia colusana*, *Psilocarphus brevissimus* (dwarf woolly-heads), and *Eremocarpus setigerus*. Among the rare plants featured in this recovery plan, five currently co-occur or historically co-occurred with *O. inaequalis*. In descending order by number of co-occurrences, these are: *N. colusana* (nine), *Castilleja campestris* ssp. *succulenta* (five), *Gratiola heterosepala* (three), *O. pilosa* (two), and *Chamaesyce hooveri* (one) (EIP Associates 1999, C. Witham *in litt.* 2000*b*, California Natural Diversity Data Base 2003).

d. Reasons for Decline and Threats to Survival

Most species addressed in this recovery plan are threatened by similar factors because they occupy the same vernal pool ecosystems. These general threats, faced by all the covered species, are discussed in greater detail in the Introduction section of this recovery plan. Additional, specific threats to *Orcuttia inaequalis* are described below.

A potential reason for some site-specific declines of this species may be foraging during grasshopper outbreaks, which can decimate entire plant populations of *Orcuttia inaequalis* before they set seed (Griggs and Jain 1983, Stone *et al.* 1988).

At least ten of the extant occurrences are threatened with habitat loss due to urbanization. Four of these are in the path of the proposed extension of State Highway 41 in Madera County (R. Stone *in litt.* 1992). Three others are threatened by a proposed residential development in Madera and Fresno Counties (Stone *et al.* 1988, Stebbins *et al.* 1995, California Natural Diversity Data Base 2003), and three more could be destroyed by construction of the proposed University of California campus and associated community in Merced County (EIP Associates 1999, California Natural Diversity Data Base 2003). Most extant populations are still being grazed; thus to the extent inappropriate grazing practices are still being followed, certain sites may be threatened. At least six occurrences are threatened by small population size. Among the *Orcuttia inaequalis* occurrences for which population size has been estimated, 6 numbered fewer than 100 plants each, even in favorable years. Ten others are of unknown size (R. Stone *in litt.* 1992, Stebbins *et al.* 1995, California Natural Diversity Data Base 2003).

e. Conservation Efforts

Orcuttia inaequalis was federally-listed as a threatened species on March 26, 1997 (U.S. Fish and Wildlife Service 1997*a*). The State of California had previously listed this grass as endangered in 1979 (California Department of Fish and Game 1991). The California Native Plant Society has considered this species to be rare and endangered for even longer (Powell 1974). Currently, *O. inaequalis* is on the California Native Plant Society's List 1B and is rated as "endangered throughout its range" (California Native Plant Society 2001). In 2005, critical habitat was designated for *O. inaequalis* and several other vernal pool species in *Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions From August 2003 Final Designation; Final Rule* (U.S. Fish and Wildlife Service 2005).

Currently, few occurrences of *Orcuttia inaequalis* are protected permanently. Two occurrences are on the Flying M Ranch in Merced County, which is protected under a conservation easement with The Nature Conservancy. Within those two occurrences, four pools supported *O. inaequalis* populations in excess of 5,000 individuals each in 1986 (Stone *et al.* 1988). The extant Tulare County occurrence of *O. inaequalis* is on a California Department of Fish and Game Ecological Reserve; it contained 250 plants in 1997 (California Natural Diversity Data Base 2003).

Three other occurrences are wholly or partially on public land. One occurrence in Fresno County consists of a pool that is partially on public land administered by the U.S. Bureau of Land Management. The pool supports the second-largest existing population of the species. The U.S. Bureau of Land Management and conservation groups hope to protect the entire pool through the potential acquisition of adjacent lands (California Natural Diversity Data Base 2003). Another occurrence is within an 81-hectare (200-acre) vernal pool complex in Madera County, where one pool contains a small population of *Orcuttia inaequalis* (Stebbins *et al.* 1995); the California Department of Transportation recently acquired this complex. Although the proposed Highway 41 extension would cross this property, alignment to avoid affecting the plant is possible (D. York pers. comm. 1996). The third occurrence on public land is the result of a vernal pool re-creation program coupled with seeding of various plant species. The California Department of Transportation funded the creation of artificial vernal pools in Madera County by staff and students from California State University, Fresno (D. York pers. comm. 1996). *Orcuttia inaequalis* was introduced into six of the created pools; it germinated and flowered in five pools during the 2 years following its introduction (Durgarian 1995, Stebbins *et al.* 1995) and was still present in 2000 (R. Faubion *in litt.* 2000). This site is now

recorded in California Natural Diversity Data Base occurrences (California Natural Diversity Data Base (2003). The Madera Irrigation District manages this property, which is owned by the U.S. Bureau of Reclamation (Stebbins *et al.* 1995).

10. *ORCUTTIA PILOSA* (HAIRY ORCUTT GRASS)

a. Description and Taxonomy

Taxonomy.—Hairy Orcutt grass is in the tribe Orcuttieae of the grass family Poaceae (Reeder 1965). Hoover (1941) published the original scientific name *Orcuttia pilosa* for hairy Orcutt grass, which has remained unchanged since. He collected the type specimen in Stanislaus County, "12 miles east of Waterford" (Hoover 1941) in 1937. Hoover (1937) initially identified that specimen as *Orcuttia tenuis*, but later recognized that it represented a new species (Hoover 1941). This species also has been known by the common names hairy Orcuttia (Smith *et al.* 1980) and pilose Orcutt grass (U.S. Fish and Wildlife Service 1985*c*).

Description and Identification.—Characteristics shared among all members of the tribe or among species in the genus *Orcuttia* are described above in the *Neostapfia colusana* and *O. inaequalis* species accounts. *Orcuttia pilosa* grows in tufts consisting of numerous stems. The stems are decumbent or erect and branch from only the lower nodes. Stems are 5 to 20 centimeters (2.0 to 7.9 inches) long and 1 to 2 millimeters (0.04 to 0.08 inch) in diameter (Stone *et al.* 1988). Almost the entire plant is pilose (bearing long, soft, straight hairs), giving it a grayish appearance. The terrestrial leaves are 3 to 6 millimeters (0.12 to 0.24 inch) wide. The inflorescence is 5 to 10 centimeters (2.0 to 3.9 inches) long and contains between 8 and 18 flattened spikelets. The spikelets near the tip of the inflorescence are crowded together, whereas those near the base are more widely spaced. Each spikelet consists of 10 to 40 florets and two tiny (3 millimeters [0.12 inch]) glumes. The lemmas are 4 to 5 millimeters (0.16 to 0.20 inch) long, with five teeth of equal size. Each caryopsis is 1.75 to 2 millimeters (0.07 to 0.08 inch) long (Hoover 1941; Reeder 1982, 1993) and weighs 0.46 to 0.95 milligram (1.6 to 3.4×10^{-5} ounce) (Griggs 1980). *Orcuttia pilosa* has a diploid chromosome number of 30 (Reeder 1982).